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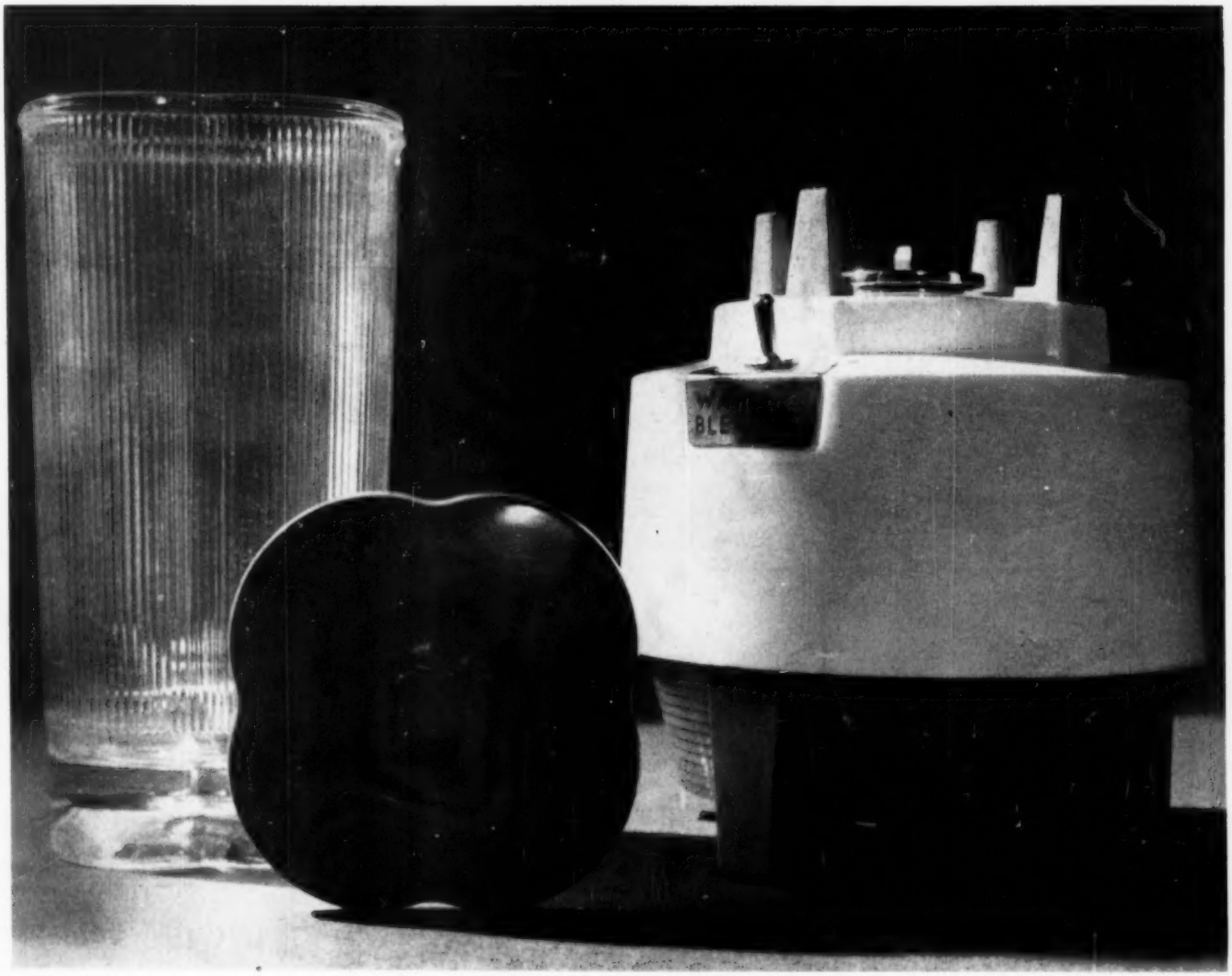
The Journal of INDUSTRIAL ENGINEERING



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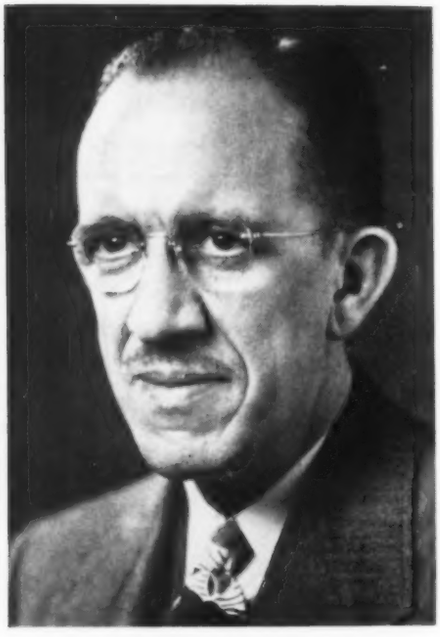
CONVENTION PROGRAM ON PAGE 11

PRESIDENT'S MESSAGE



JOHN D. COLEMAN

The administrative year that is drawing to a close has been one that has presented a great many challenges to the officers but we have been fortunate in being able to meet them, and I am pleased to report that the Institute is in the soundest position in its history.

Our principal problems center around finances and communications with our members, and those reached a climax last fall when we determined that at all costs our membership must be kept informed. The News Letter has proved to be the answer to the problem of communication until we can establish the Journal on a regular basis, and has also assisted materially in improving our financial picture.

From the splendid response we have had from industrial engineers all over the country the conclusion is inescapable that there is a very real need for an organization of, by and for industrial engineers, to develop, evaluate and disseminate data pertaining to this field. The Institute is not a perfect organization, but is is soundly conceived, growing rapidly, and deserving of the support of every industrial engineer who wishes to see this important branch of the profession grow to full stature.

The succeeding administrative year should see the Journal on a regular quarterly basis with the News Letter bridg-

(Continued on Page 11)

THE COVER

A New Product Design by
FRANCESCO COLLURA, S.I.D.,
Instructor of Industrial Design,
Columbia University's School
of Engineering
Photo Courtesy of American Cynamid Co.

THE JOURNAL OF INDUSTRIAL ENGINEERING

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EDITOR'S COLUMN

Here we go again! This will be the first issue of the JOURNAL published in Atlanta.

There is no need to go into the many reasons why the JOURNAL has been so erratic in publication during the past two years. I assure you that the problems involved have been beyond the control of the Institute and in spite of the excellent efforts put out primarily by the important Ohio nucleus which has so strongly supported A.I.I.E. from the beginning.

One of the most important things to a journal is a good supply of top articles and in this respect each of you can make a worthwhile contribution. It is also important that we get your criticisms, both destructive and constructive. It is still more important that you give the JOURNAL every support possible. The paid officers of the Society consist of one full-time secretary at our Columbus headquarters, and every effort is being made to return to you the best possible publication within the funds available for this purpose.

Since Industrial Engineering is one of the most important fields in the world today, one where top-thinking and top-action is necessary and one where workers are very scarce, it is hard to conceive that any one of you is not doing an important job somewhere. Each of us stands to gain from an exchange of thinking and ideas with each other. Ideas are one of the most important commodities in the world today and certainly one of the shortest commodities when we consider that excellent ideas are the only ideas that are worth while.

We have strayed quite a long way from that important principle which has made this United States one of the greatest countries in the world—that idea which promotes more and more products for less and less money. The Industrial Engineer is the one who must meet the challenge to turn the tide and cause the production of more goods at lower prices while at the same time increasing the purchasing power of all levels of workers. Our scientists and other researchers have done a grand job in their field. The philosophy of industrial engineering must be applied very heavily from now on in order that the fruits of this research may be made edible and put on the market at prices we can afford to pay. This applies all the way from coat hangers to the B-47 bomber. We have an oversupply of armchair quarterbacks. Let's put on a uniform and get in the lineup.

COOPERATIVE RESEARCH IN INDUSTRIAL ENGINEERING

. . . by K. Theodore Korn & Vasily D. Prian

Research Committee on Synthetic Time Systems

Throughout our studies and re-examinations of the advances made in industrial engineering since Taylor's conception of time study, one fact more than any other forces itself upon the mind of the investigator—the fact that obviously there has not been the rate of advancement achieved as has in other professional fields.

How much more can be accomplished by collaborative efforts of specialists in many fields is well exemplified by the progress achieved in Jet Propulsion, and one might realize how much longer it would have taken a group of aeronautical engineers to construct a satisfactory jet engine. The basic task would have been to construct an engine which would meet the following minimum conditions: High speed operation, long flight range, low specific fuel consumption, reliability and ruggedness, safety of operation, and simplicity of operation. Besides these, there are the requirements of relative simplicity of manufacture and field maintenance.

In its early history the life span of the jet engine was a matter of minutes because the employed metals could not withstand the high relative temperatures developed in engine operation. Since the aeronautical engineer had to work with the known, available alloys, and since he is not fully equipped to develop new alloys he could not have solved this problem without the aid of the metallurgist. The metallurgist, in turn, had to rely upon new, basic findings regarding the molecular and nuclear behavior of metals under critical temperatures which were made available to him by the physicist. He, again, depended upon the mathematician to solve equations which resulted from the transformation of ideas into models, and of models into equations. This is merely a small section of an example illustrating the complexity and multitude of the problems to be solved by cooperative research before a jet plane could take to the air, accomplish its mission, and safely return to the ground.

The sum total of advances in the young profession of industrial engineering may well be called considerable. However, it seems that the industrial engineer, generally speaking, has assumed a position of isolation, that is to say that he appears to profess his ability, by himself, fully and competently, to engage in his problem-solving activity without, on the one hand, progressively enlarging his knowledge in his own field, and on the other hand, without enlarging his knowledge of related fields, at least to the point where he may understand fundamental realizations, and apply them effectively to his own sphere of activity, and without running the risk of introducing into his 'tool kit' unfinished theories, or untested systems, and cause eventual harm in his industrial environment by the misapplication of such untested methods.

One consequence is, of course, the loss of certain fields to other professions because of the industrial engineer's failure to deal with certain problems effectively and to the satisfaction of those who are concerned with, or involved in, the problem. Examples in this category are: (1) Job Evaluation, long thought of as being in the domain of the industrial engineer, yet having little objectivity about it. When job evaluation plans were investigated by industrial psychologists[1] who were able to deal with the subject in a far more objective, and in a quantitative manner, a considerable contribution was made to job evaluation by gaining more fundamental knowledge of the functional relationships, and thus being able to evolve a simpler, more reliable, and operationally verifiable methodology of job evaluation. (2) In the case of Statistical Quality Control, which for some time, seemed to be sliding away from under the industrial engineer's seat, primarily because many men lacked the necessary training, and because it took the schools a while to readjust the curricula to the new need. And (3) in the case of Operations Research where workers in the basic sciences translated the concepts of basic research to rather typical industrial engineering problems, applied them, and came up with quantitative bases for decision—and were successful.

The 'return home' is well evidenced by two writings by Professor George E. Kimball. In METHODS OF OPERATIONS RESEARCH[2] he refers to the industrial engineer as 'efficiency experts', and one gains the impression that the belittlement originates either from their ignorance of industrial engineering which would be difficult to believe, or from a far reaching study of the advancements in industrial engineering. However, Professor Kimball recently published a paper INDUSTRIAL OPERATIONS RESEARCH[3] where he credits industrial engineering (and applied economics) as having made "a great deal of progress". Others in Operations Research, having an eye for the future, are viewing their activity as a branch of industrial engineering. It must be realized, especially by industrial engineers, that loss and limitation are in direct relation to our own amounts of knowledge and competence.

One of the significant aspects of these examples where rich fields of activity may tend to slip away from the industrial engineer is that the methodologies which had been employed by industrial engineers to solve the classified problem were displaced by other methodologies. Examination of the methodologies, the old ones and the new, discloses clearly the trend toward more objectivity, a replacement of subjective evaluations by objective evaluations, and the foundation of judgment upon quantitative analyses rather than upon qualitative opinions. To accomplish this, we often lack fundamental knowledge. Those from other fields were able to draw from knowledge in their own fields and analogously apply techniques already proven useful in their own fields usefully to industrial engineering problems.

Progress may be defined as the sum total of small advances in a professional field over the entire period of its existence. The individual advances, each by itself, may appear to be of little significance; however, reflecting upon the universal, cumulative pool of knowledge in a professional field one may well realize the magnitude. Although the rate of growth has been rapid, and has led to a wide acceptance of the principles of industrial engineering in many fields of human endeavor, the practice has been rejected in a number of quarters, has been merely tolerated in others, or is regarded with an appreciable degree of skepticism. Concepts, methodologies, systems, etc. are accepted, or rejected, because of enthusiasm, because of fear, or any number of emotional causes, or combinations of causes. A methodolgy may be successfully applied (generally accepted) in one plant, and completely fail (generally rejected) in another. Viewing the industrial engineering profession as a problem-solving function, we begin to ask: Why do systems fail? The authors do not have the answer to this

1. Lawshe, C. H., Rogers, R.C., and others.
2. Morse, P. M. and Kimball, G. E. METHODS OF OPERATIONS RESEARCH, Technology Press and John Wiley & Sons, New York, 1951
3. American Management Association, Manufacturing Management Series #200, New York, New York, 1952

question. Nor is it believed that there is *one* answer.

As a matter of fact, it is a strong conviction that one of the reasons for such failures lies in the attitude of the problem solver who carries out his work in a conceptual frame of reference which we have called the 'either-or' orientation, the choice-of-two attitude.[4] As soon as we learn to reframe our thinking to at least a multi-valued, and preferably infinite-valued orientation we begin to grow increasingly more cautious to suspend our judgment, and to rephrase our references to quantitative, rather than qualitative, decisions. This process might be called objective. It is often referred to as being 'scientific'. We are careful to impress the reader that while much of the problem-solving activity in this field proceeds in fact on a sub-scientific level, the profession of industrial engineering must finally rest upon the application of scientific knowledge. The verification and validation of industrial engineering methodologies, etc. fall into the province of the engineer-scientist. The approach to such validation may well be similar to the approach of the researcher to problems in the basic sciences. Today's researcher does primarily two things: He builds a model—and he tests the model. The scientific model is the physical construction of the idea; it must be rational, reasonable, and it must meet the rigorosum of experimental test. Above all, the hypothesis must predict to a high degree of reliability the results of the experiment which was designed to test it.

A further realization — if we have learned anything at all from the advances made in other fields—is that (1) the sum total of universal, pooled knowledge in industrial engineering has remained too small to develop tools for effective application in the field, and (2) that the relationships and intra-relationships which the industrial engineer encounters in a complicated industrial and business society require solution through methodologies outside of the professional field of industrial engineering.

During our exploratory work it became quite evident that the psychological and sociological aspects involved in the problems which industrial engineers attempted to solve were of such complexity that we became aware of our own limitations without enlisting the collaboration of specialists from other fields. Another important fact must be understood: The members of our profession are apt to get rather unhappy when their work and purposes are misunderstood, when we are, for example, identified as 'efficiency Experts', etc., yet, we commit similar offenses in relation to others. In our observations, the semantic reactions of industrial engineers in practice to activities such as industrial psychology, industrial sociology, etc. appeared to be quite similar to the semantic reactions of non-industrial engineers to industrial engineering. We fail to see that, for example, psychology has long ceased to be a philosophy of the Sigmund Freud pattern, but rather has come to evaluate phenomena in quantitative terms. The same is true of industrial sociology. The results of sociological inquiries can be expressed in definite quantities using the same type of advanced mathematical thinking which has produced Statistical Quality Control, and which Davidson, Nadler, Lehrer and others have employed in solving industrial engineering problems, and in determining causalities of phenomena in order to evolve methodologies which can find practical application by practicing industrial engineers.

Another realization is that most new concepts in industrial engineering soon fell victim to commercialization, and it often appears that had more time been taken in development, verification and validation, many individual advances could have yielded considerably more basic knowledge, and consequently more lasting contributions of greater usefulness. Based upon our knowledge of the effectiveness of collaborative research in other fields of endeavor we began to look for sources of collaborative research in industrial engineering. Our search has yielded little.

Our search indicated that there were individual researchers, who were conducting basic and applied research in specific phases of management, however, their work was done in obscurity and without the support and strength which comes with organized, coordinated, collaborative activities. It was, moreover, soon found that a large degree of mutuality existed between such individual researchers, and that the organization of this group was welcomed by those who were far sighted enough to realize the advantages of, and the need for, this type of organization.

Following this general criticism of the inadequacies of industrial engineering, it must be admitted that no worthwhile progress can be made without such self-criticism, and without recognizing to some degree the shortcomings. We may then have a starting point for improvement.

A listing of Areas of Research is in preparation. Some of these may be thought of as "basic" research, and it is understood, of course, that one cannot project results which are expected to be yielded from such projects; as a matter of fact, one hesitates to expect any yield until such work is well along its way. Other areas fall definitely into the classification of 'applied' research and results will definitely be forthcoming. Several projects are already under way. The Methods and Standards section of the Industrial Engineering Department of the Ohio State University is conducting an inquiry on The Equivalence of Different Perceptual Stimuli in Rating.[5] This investigation is being conducted by Richard W. McGuire, formerly a faculty member at Georgia Institute of Technology, now a Research Fellow at the Ohio State University, and one of our Research Associates. Although this research has not, as yet, been brought to completion, the following report on McGuire's work may be made at this time:

There has always been some means of recognition of individual differences in the operators which perform the industrial operations. The problem was initially met by means of personnel selection which in Taylor's case was the choosing of the "first class" man for the job. Disciples of this system attempted to follow its pattern but through the course of time one finds greater deviation from the original conception. Variations in production rates were the rule rather than the exception and many reasons were given to explain this variance from the standard set by time study. The first real contribution to this section of the field of time study was made by Lowery, Maynard, and Stegmerten when in 1927 they made public their system of "leveling."

Leveling attempted to convert the times observed by the time study man to those which would represent those of the average operator, or more specifically, to those which would be compatible to the definition then existing of a normal time. This was done by taking into account factors which were supposed to cause the individual differences. An algebraic summation of one plus the percentage assigned to each of these factors for the given job, resulted in a rating or leveling factor which when multiplied by the selected time from the observed times, resulted in the normal time. Variations from this method have evolved in the past thirty years, but the end result of obtaining a rating factor by which the selected time must be multiplied, still remains.

There may be objections from some quarters of the field to an investigation into the subject of rating, on the basis that synthetic time standards are a more advanced methodology of setting rates; hence, the stop watch technique is rapidly becoming outmoded. To this it might be pointed out that the primary objection to the stop watch technique is the use of qualitative judgment. Although the proponents of synthetic time standards say that rating is eliminated,

4. Korn, K. T., MANHOOD OF INDUSTRIAL ENGINEERING, RCOSTS, 1951

5. McGUIRE, R. W., THE EQUIVALENCE OF DIFFERENT PERCEPTUAL STIMULI IN RATING, a forthcoming RCOSTS publication.

other objections were found to the systems which are worse than the objections raised against the conventional methods of time study. In order to substantiate this point attention is called to the facts that (1) the data upon which synthetic time standards appear to be built are insufficient, (2) a rather large amount of qualitative judgment enters into the compiling of all systems of standard data, (3 the known systems to date, differ markedly both in end result as well as basic proportions, and hence all cannot be correct, (4) judgment and individual differences are still present at the application level.

Because of these facts it is believed that the stop watch technique should not be sold short for questionable new methods, but that we should improve that which exists until such time as it meets the criteria set forth for it, or a methodology is proposed which meets the criteria. By this reasoning we felt justified in initiating investigations such as those described here.

McGuire reasons that it is frequently the case that data secured to arrive at a given question, may well be used for the investigation of other similar questions; we will find this to be so in this case due to the design of the experiment. Although the primary question of the experiment is concerned with the equivalence of two stimuli, it would be well to know the relationship and interactions of the various factors contributing to, or being primarily involved in, the end result. First and foremost, we wish to determine the equivalence of two entirely different stimuli; one is tridimensional, is possessed of sound, is clothed in reality; the other one is bi-dimensional, is artificial, and is foreign to the previous stimulus. There are particular factors which must be brought together to produce both of these. The film is directly dependent upon the existence of the actual operation, while the actual operation is dependent upon the existence of the job and the operator . . . the ratings of both are dependent upon the observer. This gives us four variables with which we must work simultaneously . . . the stimulus, the observer, the operator, and the operation.

Statistics offer a very convenient tool for handling multifactor designs . . . the analysis of variance. By means of this technique we are able to get variance estimates of each of the multi-classifications and their interaction with each other. An application of the F test enables us to calculate the level of significance of each combination. With such a useful tool at hand McGuire decided to design his experiment around this technique; hence, the basic form of analysis will be the complex quadruple classification of the analysis of variance.

For observers in the experiment, twenty advanced Industrial Engineering students who had had previous industrial experience were chosen. Their status was considered as being inadequate without further training in all aspects of the matter of rating. A program was outlined so that the group received a balanced schedule which contained theory, rating practice on films as well as actual operations, and tachistoscopic training. Tachistoscopic training is a technique developed by Dr. Samuel Renshaw to increase the perceptual abilities of the individual; and has proven very successful in actual application, when used by the Army and the Navy as well as by several industrial concerns. Basically, the technique is a means of short time exposure (one hundredth of a second) of a stimulus in order to force the individual to see the stimulus as a unit or whole; by gradually and systematically increasing the size of the stimuli, the subject is forced to perceive larger and larger units. The entire program was projected over a three month period so that at the end of that time, the observers were trained to a degree far beyond that which the college student normally receives rating training. Following the training, the group was divided into two equally matched groups such that the sub-groups were matched as to total ability and individual ability.

The next step was the selection of a stratified sample of jobs which met the following series of criteria: (1) the ratio of man time to machine time was high, (2) the time length of the cycle was relatively short, (3) the operation was man paced not machine paced, (4) at least four well trained operators who normally perform the task, be available for observation, (5) the jobs selected represent a rather wide latitude of job types from heavy manual jobs to intricate dextrous operations. Twenty-three operations were selected from industry which met these criteria thus yielding ninety-two operator-job combinations.

These operations were rated by sub-group "A", while simultaneously being photographed; Sub-group "B" would rate the film. This process was reversed on the next operation; that is to say, sub-group "B" rated the actual operation so as to act as a check and balance against any defect in matching. Through this procedure each sub-group rated an equal number of actual operation and film.

Once the data was gathered it was arrayed in the post, column, line and layer form to lend itself to statistical analysis. Standard deviations of each of the operator-job combinations were computed, and graphical analyses of these were performed. The films were analyzed for cycle times, fumbles, and motion patterns. At the date of this writing, the complete statistical computations have not been made and therefore the conclusions drawn will not, in any manner, be complete but will merely be an indication of the trend of the data thus far analyzed.

It may be concluded that:

(1) The variability among observers is not a constant, and is generally higher than the 5% generally quoted.

(2) The variability mentioned in (1) is not primarily attributable to such factors as methods differences, fumbles, degree of productivity, etc., but seems to be correlated to all in some minor amount. To properly determine this, a multiple correlation analysis would be necessary.

(3) In most instances the agreement between film and actual operation rating means is surprisingly close. The significance of any differences cannot be told until a complete set of statistical computations are finished.

(4) The general belief that an observer having a conception of "normal" can accurately rate any operation, is not up-held by the data thus far analyzed.

It is to be noted that McGuire constructed his experimental design around the statistical methodology of the analysis of variance, a tool supplied by the mathematician which has found many applications to prove its usefulness. It was also noted that he used the tachistoscope for perceptual training of the observers, a device developed and designed by a psychologist[6] and the usefulness of which had already been amply demonstrated. We believe this to be one example of cooperative research in Industrial Engineering and we are confident that, once completed, McGuire's work will yield important additions to the universal pool of Industrial Engineering Knowledge.

A second important project has been explored by Harold O. Davidson[7] and the results of which are available in his forthcoming publication.[8]

This work is neither a handbook nor a text on how to make time studies. The author has no favorite system to expound but rather attempts to present an integrated perspective of the field of time study—past, present, and future. A final hundred pages are devoted to reports on a number of research studies conducted by the author and his associates.

The interest of some readers may be drawn primarily to the specific results of research reported by the author. It would seem to the reviewers, however,

(Continued on Page 18)

6. Dr. Samuel Renshaw—Ohio State University.

7. Dr. Davidson is in charge of graduate work and research in the Methods and Standards Area in the Department of Industrial Engineering, The Ohio State University. He is also serving as an Associate Director of Research on the Research Committee on Synthetic Time Systems.

8. Davidson, H. O., FUNCTIONS AND BASES OF TIME STANDARDS.

PRODUCTIVITY, HERE AND ABROAD

Speech by Ewan Clague

COMMISSIONER OF LABOR STATISTICS,
U. S. DEPARTMENT OF LABOR

Before the Second Annual Convention of the American Institute of Industrial Engineers, Cleveland, Ohio, June 16, 1951

Basically, productivity is the relationship between *input* (expressed in terms of manpower, capital investment, machinery applied in production, electric energy, mechanical energy, or other forms of power, or various other factors) and *output*, expressed in terms of physical units, in dollar value of production, dollars of sales, or value added by manufacture. We in the Bureau of Labor Statistics have found that the most manageable productivity measure, and the one which is most nearly comparable from industry to industry, is the relationship between *physical man-hours worked* and *physical units of production*. This relationship may be expressed in terms of the level in any one period, or in an index expressing changes over a period of years.

Productivity measurements may be expressed in any of a number of degrees of scope and exactness—ranging from the intangible but comprehensive expression of gross national product per capita to the precise engineering time analysis of man-hours required to perform one specific operation in a particular factory. The Bureau in its various programs now carries out different types of measures which can bridge the vast gap between these two extremes—(1) the *general industry index* of output per man-hour based on secondary-source materials, which is within reasonable distance of the gross national product measurement; (2) the *direct report* of trends in man-hours expended per unit of product which, like the general industry index, provides information on the average trend for a segment of industry, but in addition provides details in terms of individual products, processes, or factory departments, for both direct and indirect labor; and which relates productivity trends to important factors affecting productivity, such as production method, technological change, utilization of plant capacity, etc.; and (3) a new program of *case studies and factory performance*, which provide one-time analyses of factory productivity in the manufacture of specific products, in terms of processes or departments, and also for all of the major individual occupations within each department—thus approaching the detail provided by the industrial engineer's time-and-motion study.

A nation's productivity is unquestionably one of the two major determinants of the way of life of its people. The other, of course, is the sociopolitical system under which the nation is governed. During the past century or more most of the advanced industrial nations have established democratic social and political systems. However, no political system, no matter how liberal and democratic it may be, can yield a high standard of living for the people unless the economic system of producing goods and services is productive and efficient. The American people are blessed with more goods and services and more leisure time than any other nation, but this is not due solely to our vast natural resources. There are other countries which are more richly endowed than we are. The American standard of living is due to the development in this country of a high rate of productivity which exceeds that of any other country in the world. In other words, the land and the other natural resources were put to good use by an enterprising and productive people under a system of political democracy.

Relatively little accurate, comprehensive and up-to-date information is available to compare American and European productivity on comparable products from industry to industry. The Bureau is now working on studies which may in time lead to the development of more complete information of this type. Such information as we have, however, gives conclusive indications that in general productivity is much higher here than abroad. In most industries, United States productivity outstrips even the most advanced countries in Europe in a ratio of three or four to one, and more in some industries. This great advantage is due in part to our more advanced technological (machinery and equipment), in part to our technical know-how in production, in part to the large scale of relatively standardized output in most U. S. factories (as compared to the typical European plant), and to many other more intangible factors as well.

Although the U. S. has a lower productivity than some industrial nations of Europe in a few industries, the predominant pattern is one of great American superiority, in some cases as much as five or six to one. This means simply that American industry economizes on labor to a degree unknown in most other industrial nations.

For several decades prior to World War II productivity in the U. S., as measured in output per man-hour of labor, increased at a rate of from two to three per cent per year. The exact figure is not available, and in many cases even an approximate figure depends in part on the kinds of industries included in the measurement. For example, in manufacturing the rate is nearer three per cent; in agriculture it would hardly be that high; in certain types of consumer service industries no adequate measurement has been made. Since the beginning of World War II productivity in the U. S. has risen to new high levels, but the rate of increase is considerably below three per cent per year. This is partly due to the fact that industry was greatly dislocated and disorganized by the war; first, in the conversion to war production and later in the reconversion to peacetime industry.

In Europe, productivity suffered greater losses during the war than in the U. S. In some countries like England, the conversion to war was more complete. In other countries like France, Germany and Italy, there was considerable war destruction, to say nothing of the failure to maintain a satisfactory rate of new capital investment. Recent evidence indicates that there was considerable improvement in productivity in many European countries during the period 1947-50.

The question arises as to why there should be such basic differences in productivity and living standards between the U. S. and Europe. Some of the reasons ordinarily given to explain these differences are not valid. For example, the differences are not due primarily to the inherent wealth and resources of the U. S., although this nation does have vast natural resources. Nevertheless, many Europeans attribute the differences to this one factor—a misconception which is doubly harmful; first, it is not as important as the Europeans think; and second, it weakens their incentive to improve their own productivity.

A second prevalent misconception is that these differences between the U. S. and European countries developed overnight, that is to say, since World War I perhaps. This is not true; these differences have grown steadily for over a century and a half, with particularly rapid growth during the past half century. The differences are due to some-

thing more fundamental than the losses a nation suffers in war.

There are sound and solid reasons for the productivity advantage which the U. S. has obtained. These can be summarized in the following points:

1. Early development of a mass market, based on the demand for goods from a growing populace, the widespread application of the principle of interchangeable parts, and the application of power and machinery to standardized production, rather than limited-volume craftsman-type production.
2. General and widespread application of capital investment on a large scale for the latest and most efficient types of production machinery and equipment; flexibility in applying capital; imagination and open-mindedness on the part of those applying the capital; with willingness to change or replace old equipment with new and different types; encouragement of experimentation.
3. Rapid development and continued growth of alert management; steady pressure of competition; strong initiative on part of business and management, seizing of opportunities for expanding markets; early awareness of the importance of leadership, and adaptability to change.
4. Development of individual initiative and a sense of participation on the part of industrial workers; adaptability to changes in production methods; development of basic business-like attitude on the part of organized labor, with participation in the development of improved techniques, sharing in productivity gains; encouraging technological advances.
5. Development of production engineering and scientific management engineering; participation of industrial engineers in planning and organizing for efficient, low-cost, high-productivity output for a mass market. Development of close relationship between product engineering and production engineering, with adaptation of products to conform to requirements of efficient manufacture without sacrifice of quality.
6. Development of industrial research on an organized basis for improvement of efficiency, development of new ways of making better products more efficiently. Note that this phase is at the present time in a state of rapid growth and increasing importance.
7. Development of large-scale advertising for the purpose of building and shaping consumer requirements, as a means of making possible mass markets for goods and low prices for quality merchandise.

The significant developments sketched above in summary fashion have led to profound changes in the American production and marketing system. A partial list of these changes is as follows:

1. Improved technology and work techniques.
2. Lower unit costs.
3. Broader market and increased volume.
4. Lower prices.
5. Larger return to capital, encouraging new investment and making possible more engineering and research.

These trends are in sharp contrast to the prevalent tendencies in the industrial countries in Europe. There the usual practice is low-volume controlled production for a limited market, with high unit costs, low wages, and resistance to change or technological improvement because of the fear of technological unemployment or the failure to spread the gains of increased productivity throughout the population. The result is that neither labor nor management in the countries of Europe have the same interest in productivity that is found in management and labor groups in the U. S.

The problem for Western Europe is that of creating circumstances and incentives which will make possible a marked increase in productivity. The standard of living in these countries has not risen appreciably since prewar years. A magnificent job has been done in restoring industry to prewar production levels. On the other hand, these countries are now faced with the necessity of increasing their armaments for defense. This means that the armament program must compete with the standard of living of the masses of the people. The only long-run and sound solution for this situation is a sharp and continued rise in the productivity. If this can be achieved it should be possible to increase armaments and at the same time to raise, at least to some extent, the standard of living.

The U. S. has made a number of important contributions to this productivity. The Marshall Plan provided funds to restore prewar production. The Economic Cooperation Administration program was attempting to make American productivity experiences available to European countries. One important point is to have the peoples of Western Europe understand the reasons for high productivity in the U. S. and to learn how to apply American experiences to their own individual industrial systems.

Formation of Local Chapters

Prepared by Chapter Organization and Extension Committee

As members of a fast changing and growing profession, industrial engineers must work continuously to keep pace with the field. Perhaps the most effective yet pleasant way of doing this is to participate actively in the affairs of a local A.I.I.E. Chapter. The national A.I.I.E. organization recognizes this and is thus anxious, in every way possible, to assist its members in the formation and maintenance of new chapters.

Study the following list of benefits of the local chapter. Consider how these will enrich your personal and professional life; how they will assist you with your work; keep you informed and insure you a top secure spot in your field and in your company.

Professional Contacts

The opportunity to meet frequently with other industrial engineers in the community to discuss and work out common technical problems.

Technical Sessions

The opportunity to plan and present programs consisting of papers, debates, panel discussions and forums.

Visitations

The opportunity to arrange and attend plant inspection trips to view industrial engineering techniques on the job.

Committee Work

The opportunity to follow specific problems of company or personal interest with the assistance of fellow members.

Technical Expression

The opportunity to prepare and present technical papers to express one's self in open forum, to cooperate on interesting research projects.

Professional Leadership

The opportunity for experience in conducting the work of others through committee chairmanship, round table leadership, or as a chapter, regional, or national officer.

Social Contacts

The opportunity to expand acquaintances and to meet socially with industrial and community leaders with the strong common bond of mutual professional interests.

Job Opportunities

The opportunity to learn firsthand of openings and job transfers within the industrial engineering community, plus the opportunity to meet and appraise prospective employers (or employees).

Salary and Promotion Data

The opportunity to survey and appraise salary and promotion policies and practices in the community.

Professional and Vocational Guidance

The opportunity to receive guidance

(Continued on Page 18)

FATIGUE AND TRAINING

. . . by A. B. Segur, A. B. Segur & Co.

As presented to the American Institute of Industrial Engineers, National Convention, 1950

One hears much about both fatigue and training. Few people seem to realize that the factors that control both are very similar. This paper will deal with their common relationship.

When considering fatigue the term should not be confused with fatigue allowances. Many fatigue allowances have very little to do with fatigue. The standards department has learned that they cannot use their time observations to determine pay without an adjustment factor. This factor is given many names. One of these is fatigue.

The factor applied depends entirely upon how the observation is taken in the beginning.

Suppose we consider a hypothetical case. A man or group of men are following a method of operation more or less consistently. A foreman times them for two hours. His production figures show 268 pieces produced per man in two hours. He adds 18% to the production to obtain the expected production. He says, therefore—

$$\frac{268 \times 1.18}{2} = 158 \text{ per hour}$$

A time study man observes the time by pieces. His times are as follows:

					Total	Ave.
.30	.39	.42	.29	.33	1.73	.346

He says, I will allow 10% for fatigue and incentive. His figures look liks this—

Our time per piece .346
Allowance .346 x 1.10 = .38
But 60 ÷ .38 = 158/pcs./hr.

A second time study man looks at the job. He makes his study by elements. His figures are as follows:

					Selected Time
.03	.02	.02	.04	.03	.02
.08	.10	.10	.06	.07	.06
.02	.04	.04	.02	.04	.02
.06	.08	.10	.05	.08	.05
.04	.05	.06	.04	.05	.04
.07	.10	.10	.08	.07	.07
—	—	—	—	—	—
.30	.39	.42	.29	.34	.26

He selects the minimum of his readings to give a sum of .26.

He then says—

Fatigue 10%
Personal 5%
Total allowance 15%
.26 x 1.15 = .30

He then settles on 27% incentive

$$\frac{.30 \times 1.27}{.38} = \frac{60}{.38} = 158 \text{ pieces}$$

A Motion-Time-Analysis man gives a detailed description of each motion on the job. His description is so accurate that no man could follow the description and fail to get the proper result. He uses no watch. He simply applies standard times to each motion. When he finishes he has 20 pages of written matter. His answer is .212 Min.

The chances of an operator beating this time at the start are very remote. On the other hand, practically all qualified operators will equal the time for a portion of the cycles.

When operators are controlled so closely even the qualified operator will make mistakes in the method of performing the majority of the cycles. The number of mistakes made will depend upon how much the attention of the operator is divided during the operation. Therefore we always add from 5% to 30% to the base time to allow for these inevitable errors.

In addition, we add 10% for fatigue and 5% for personal. The actual requirement for these factors varies with every operator. In the beginning we made these two allowances because others were making it. Through the years of performance the operators has seemed to justify these percentages.

Mistakes 20%
Fatigue 10%
Personal 5%
Total 35%
Then .212 x 1.35 = .286

This represents the average time of the expert operator. Therefore all incentive must be added. He therefore allows for incentive, 33%.

$$\text{Therefore } .286 \times 1.33 = .38$$

$$\frac{60}{.38} = 158 \text{ pcs. per hour}$$

Many people have undertaken research to reduce fatigue to exact allowances. So far we know of none that have succeeded. One of the best treatises on fatigue is "The Human Motor" by Amar. This book contains much valuable information on the general subject. But Amar found a wide variation in endurance between individuals. The remainder of this paper will attempt to explain why such studies are so difficult.

Fatigue is of two types—physical and mental or nervous. Physical fatigue expresses itself in heavy oxygen consumption, in muscle strain, in excessive action of the waste organs, in a tearing down of the bodily organs. Nervous or mental fatigue expresses itself in a different way. There is a trembling of the muscles. The aim or timing of the body is not so accurate. The operator becomes dull. Interest is lost in the work done or the surroundings. On the other hand, inhibitions are lost. Talk may become loud. Foolish laughter takes the place of calm decorum.

There are very few jobs indeed nowadays that lead to excessive physical fatigue. The signs of such fatigue are too evident. Jobs where work is done under excessive heat or cold are good examples. Still cleaners in the oil refining industry formerly worked in temperatures as high as 450° F. Now these workers seldom work in temperatures exceeding 225° F. Means have been found and are constantly being improved for cooling the stills. Blast furnaces were formerly charged by hand. Mechanical men now take their place. Foundry molders formerly carried out all molds. Conveyors are taking their place more and more. Atmospheres of dangerous gases are being cleaned constantly. The prevention of hernia is under constant study. Perhaps one of the last hernia producing industries to be humanized is now the bricklaying trade.

The existence of mental fatigue has not been so easily recognized. This form of fatigue is very much magnified in the person who has allowed his system to be weakened by dissipation. The excessive use of narcotics and alcohol can nearly always be distinguished by the quick nervous fatigue of the subject. Many strikes have been caused by the fact that a portion of the workers were suffering from some form of nervous fatigue.

A great deal of what is considered muscular fatigue is really nervous fatigue. In order to understand this type of fatigue we must consider some simple physiology. Each of you know that each movement of the body is the result of muscular contraction. Each small muscle fibre (sarcostyle) is a unit in itself. If the load is very heavy many sarcostyles pull as a unit. If the load is small only a few act at any one time. Each muscle fibre pulls full distance of which it is

capable when once it starts to pull. The movement caused by any one sarcostyle is very short. The average body movement is really a rapid succession of movements of sarcostyle units.

Each sarcostyle consists of a short fibre. At each end is attached a small tendon. At the side is attached a nerve ending. The nerve fibre (ganglion) leads off from the sarcostyle. The impressions to the nerve ending come from the brain. The sarcostyle cannot contract unless the order comes from the central nervous system. Where the muscle contracts lactic acid is created in the neighborhood of the muscle fibre. Under normal circumstances this lactic acid is oxidized by the lungs. If it is created too rapidly at any one point it cannot be carried off rapidly enough. The lactic acid then attacks the nerve endings. The orders cannot reach the muscle fibre. The fibre acts improperly or not at all. Fatigue has taken place.

Suppose we consider a very simple test. This is known as the tapping test. Provide a simple table or desk at normal writing level. Provide two surfaces with a difference in elevation of from one-half to one inch. One is a sound-deadening surface such as paper or felt. The other is a sounding surface. The subject holds a simple tool, such as a knife or the wooden end of a lead pencil. The subject gets himself set. He then strikes first the deadening surface and then the sounding surface. This is repeated at the operator's best speed. The speed must not be less than 29 full taps in .15 min. Keep track of the time at which the muscles no longer coordinate properly. The muscles cannot move from one surface to the other. Or the tapping is manifestly faulty. People generally think in terms of hours for the time for fatigue to develop. Not one person in one hundred can keep up this tapping for 20 seconds. If now this same fatigue takes place near a dangerous machine, the hand is just as likely as not to go to the danger area and a hand is lost. If the controls of a machine are being handled the machine may be guided the wrong way. An automobile crash may take place or production may be slowed down. The more difficult the operation the more chance there is that nervous fatigue will cause difficulties.

Many jobs require close attention and thinking as well as active physical work. On such work any distraction slows production. Mental fatigue makes the operator more susceptible to distraction. The result is a vicious cycle.

Needless to say, the amount of nervous fatigue varies greatly. It varies between people and varies from day to day for the same worker. Manifestly the provision of a time allowance is not the answer to fatigue. The first answer is the elimination of the cause of the fatigue. The next answer is the elimination of the harmful effect of the fatigue.

Many years ago we had the job of training tire builders. In one plant we set up a standard that was 30% higher than the plant had ever been able to ready before. The company decided to test Motion-Time-Analysis training. They assigned to us the man they considered to be the poorest tire builder in the room. To our utter surprise he came up to a full speed on the operation within about three weeks. No one had been able to beat his record. Then we left him. The next day his production was down to his old speed.

It was difficult to find the cause. The man was not loafing. Finally we tried an experiment. At some point in the operation in the building of each tire, the instructor would simply tell him what to do next, nothing more. The production went up to his top standard. The instructor stopped coaching. The production went down to his old standard. The man could not mentally concentrate for the time required to build one tire. The concentration was broken up. Full speed was the result.

You will find many operators of this type. Many times the use of a metronome, the regular click of a piece of machinery, an understanding word of encouragement from the boss, anything that will bring the operator's mind back to the job in hand will take away the nervous fatigue and will restore production.

Today, on manufacturing operations, at least 80% of all fatigue is nervous fatigue. If you attempt to take care of nervous fatigue simply by allowances you will probably reap low production, dissatisfied personnel and labor difficulties. Put yourself in the place of the operator. Remember that you sometimes get tired and bored also. Think the job through first. Arrange the job so that you would like to do it if you were the operator. Do not depend upon the operator trying to figure out just what you meant when you designed a piece of machinery. Tell them what you mean and then be willing to accept the responsibility for the method you have designed. If it is wrong, be willing to admit that you made a mistake.

When the operator is being trained do those things to aid and instruct the operator that you would want done if you were the operator. Remember that disciplinary fatigue and nerve fatigue are real problems. Do those little things that would bring back your interest if you were bored. The pay envelope is important, but other things are important in a plant also. If you will remember these things your company will reap the benefit that goes with higher production and better labor relations. You can stand back and look at the job you have done and have some sense of professional pride.

Work Methods and Work Management Clinic

Sponsored by the Dayton Chapter
May 8th and 9th

Increasing production efficiency by methods improvement, work measurement, and wage incentives will be the chief subject of a two-day clinic sponsored by the Dayton Chapter of the American Institute of Industrial Engineers in Dayton, Ohio, on May 8 and 9.

Dr. Ralph M. Barnes, Professor of Engineering and Production Management at the University of California and Western Vice-President of A.I.I.E. will conduct the sessions.

Dr. Barnes is internationally known for his work in the field of industrial engineering. He is the author of texts which have become standard reference works in time and motion study, work simplification, and related subjects. For ten years he has conducted the famous summer management course at the University of Iowa. He has maintained his contact with the practical problems of industry through his work with industrial organizations all over the United States.

Subjects covered in this intensive course will be: Objectives of Industrial Engineering, Motion Study and Its Tools, Methods of Increasing Worker Productivity, Process Analysis, Equipment Utilization, Design of a Methods Training Program; Work Measurement, Time Study, Elemental Data, Motion-Time Data, Performance Rating and Accepted Practice in These Fields; Fundamentals of a Successful Wage Plan and Why Some Plans Fail. Those attending will also have an opportunity to participate in Dr. Barnes' work measurement survey.

The clinic is designed to provide a realistic and practical program for industrial engineers, plant managers, superintendents, foremen, time study and methods men, cost accountants and office executives.

Information regarding the clinic and the 1952 National Convention of the American Institute of Industrial Engineers which follows on May 10 may be obtained from R. E. Allen, Univis Lens Company, 401 Leo Street, Dayton 1, Ohio.

An Arbitrator's View of Timestudy Incentive Application Problems as Related to Union Contracts

. . . by G. Jay Anyon,

Wharton School, University of Pennsylvania

It is upon those occasions when the Industrial Engineer is asked to justify his decisions and actions that the arbitrator views these phases of the Industrial Engineering Practices in Industry. Taking the liberty to tap a limited universe of experience and to generalize upon it, at this time, the aspects that stand out in bold relief are as follows, cast in the form of questions:

1. How has the technical phase of work been done? Can it withstand the challenge and onslaught of criticism?
2. Has there been the recognition of the human element involved in the work done? What is the impact of the action taken upon the acceptability sought?
3. Has there been a proper recognition and evaluation of the institutional forces at work in the situation? What is the effect of the action on existing patterns?

In answers found to each of the above questions (there are others not now to be discussed), are established the determinants that create the issues and the substance of Collective Bargaining over Industrial Engineering practices related to Timestudy and Incentive application.

Once the Industrial Engineering practices are brought within the scope of Collective Bargaining the Industrial Engineer is bound by the contractual obligations stipulated. As an Industrial Engineer he has given, in an "a priori" sense, some of the "laws of the situation" that he must take into account in his work.

To review some of the experiences in relation to each of the identified aspects, in as succinct a manner as possible, the most prevalent will be identified.

1. In regard to technical phases of work the following has been observed:
   Where all elements and/or conditions are not under adequate control, adequate allowances are not made to absorb the incidence of occurrence of the uncontrollables. The production study as a timestudy technique often is not given its proper place in the methodology of the Industrial Engineering Dept. Too much reliance is placed on an additive accumulation of job studies' data.
   The statistical nature of timestudy, and the fact that the study made is a basis for prediction is not always sufficiently recognized. The necessary steps are neglected to accomplish an approximation of a "natural distribution" of occurrences inherent in the "law of large numbers." Where the "law of economy" does not permit the number of observations to accomplish this in the most direct manner, the necessary precautions that can be taken to establish a sound judgment upon which to "normalize" the data are often neglected. Where care and caution is taken and consistency is achieved the achievement is often undone by the insistence upon the results being accepted as absolute and infallible. There is often a refusal to accept the results as approximations, and at its best, probabilities within which have not been resolved the problems of individual differences. There have been occasions where the simple rule of thumb, that reflects the statistical nature of the data, has not been acceptable. This rule of thumb—"Is task achieved around 85% of the time and is the best achievement more than twice the achievement of the worst performance?" has upon occasion introduced a sobriety that matches the performance of oil cast upon rough waters.
   The ultimate objective in the incentive application of Timestudy (in its narrowest frame of reference) is often forgotten and neglected. In essence the objective is to accomplish task determinations that establish uniformly difficult tasks throughout the area of application. At this juncture we are back to the first point raised in considering the technical phases of work in the reflection of the operating conditions. Yet, it is an aspect of the application to incentives that is not examined carefully. It serves as one of the best criterion of the technical proficiency achieved in task determination.
2. In regard to the recognition of the human element involved the following has been observed:
   Where a task-incentive design is not in consonance with the cost structure of the given enterprise, pressures are exerted to "squeeze" from the incentive system savings that are nominal, by schemes and subterfuges. The willingness to "go along" on the part of top management is a direct reflection of this one element. It would seem at times that the only savings sought are labor savings even though the greater reservoir of savings accrue from increased volume and the resultant reduction of a high fixed burden on each unit of output. In ignorance of the real source of savings, the machinations to capture more of the labor savings result in a mental set on the part of operators that limits the output (in fear of rate-cutting for example) and thus misses the real source of savings inherent in the cost structure.
   Similarly, where labor costs are a high percentage of cost of production there is often the failure to recognize that in reaching the "incentive level" of activity from the "day-rate level" is the real source of savings even though unit labor costs remain constant. This leads to attempts to tamper with piece-rates that result in the mental set that defeats the whole incentive program.
   At times the same problem is created when the reward is associated with achievement between "what can be done" and "what should be done" that diminishes the incentive to achieve a greater level of accomplishment because of the decreasing rate of reward as greater achievement is attained.
   In other words, the human element is not presented with a task-incentive design and a sufficient explanation of the benefits accruing to each and all of the parties in the situation that eliminate the need for chiseling and soldiering. A willingness to go along is not a propaganda job. Abracadabra and mystery that often is relied upon is usually based upon a failure to fit the needs of the situation in the task-incentive design and an attempt to "force it" through, anyway and/or anyhow. That is, until it "blows-up" in a crisis or emergency that renders the human element an insurmountable obstacle to the entire Industrial Engineering program in the enterprise.
   Too often is the financial incentive plan forced to stand by itself. In the absence of non-financial incentives the psychological impact of financial reward eventually loses its punch. As a result, any difficulties weaken the incentive power of the financial reward offered. Should difficulties

in the task-incentive plan become chronic, the absence of non-financial incentives allows the eventual dissipation of the interest of the people in the entire setup before the difficulties can be worked out.

3. In regard to the institutional forces at work in the situation the following has been observed:

When a financial incentive plan is believed to be a panacea and cure-all rather than the capstan to a comprehensive manegement program the impact on the existing situation can be highly disturbing and volatile.

In some cases the interrelationship of earnings are so upset, throughout the hierarchy of jobs in the area of application, as to defy rectification. In addition to the internal alignment problem the external alignment of job earnings may result in a mobility of labor that can wreck a lot more than just wage-schedules and/or an incentive program.

Very often the task-incentive plan is subjected to a "treatment" that can be traced to the attempt to gain on that "front" what had been lost on another "front" of bargaining between the parties. The reverse is also true, in many cases. Generally speaking, it is apparent that the "Industrial Relations Climate" establishes the type of "weather" experienced by the timestudy incentive program.

The security of the Union and its growth requirements and the security of management and its needs in performance of its functions will be reflected in the behavior of each of the parties in relation to task-incentive plans. Past experience of the parties may often make difficult adjustments to each other in the execution of any plan that otherwise might be made workable.

As a result of such "carryings on" and as a reflection of the relative bargaining power of the parties involved this area of management function has been brought within the scope of Collective Bargaining. The patterns apparent in the way this task-incentive application activity is brought into the scope of Collective Bargaining has been identified along these lines:

a. Mutual consent clauses in the trade-agreement have been established in cases of original installation and in cases of changes to be involved in the administration of a plan.

b. Joint committee clauses in the trade agreement have been used for purposes of installation of a plan, its extension and its administration.

c. Clauses have been written into agreements that establish limits upon the discretion to be exercised in the installation, extension and in the administration of plans. Guarantees in results to be attained have been established in terms of absolute values.

d. Provisions have been established where the "right to grieve" against actions taken include the unlimited use of arbitration before a third party.

There is no place, in this discussion, to establish the right or wrong aspects of these actions. The important thing for the Industrial Engineer to recognize is that the task-incentive program must function within the limits established.

There are two levels at which these limits are created. The first is at the point where contractual obligations are established reflecting the interests identified for themselves by the parties involved in Collective Bargaining. Most often the Industrial Engineer has no part in this activity, directly.

The second level is where complaints and grievances are created to bring into focus a challenge of the interpretation and application of the contractual obligations created at the first level. At this level the Industrial Engineer is right in the middle of it.

When the Industrial Engineer does come upon the scene his role is type-cast for him. He must adjust the "logic of efficiency" that has guided his efforts to the conditions under which it will "prove to be acceptable." His position allows him but one source of flexibility. His flexibility in making his adjustment is tied to his ability to justify his actions. His justification, however, is an element of solution that must be present within the circumstances created by the contractual obligations established by Collective Bargaining.

The more mature Collective Bargaining becomes between the parties involved the more flexibility be available to the Industrial Engineer to contribute to wage determination. However, it must be remembered that there are non-economic factors involved in wage-determination as well as the economic factors. Thereby, the Industrial Engineer and his task-incentive program will never be unfettered. To the extent that in each given situation, the Industrial Engineer in creating his task-incentive program can justify his decisions and actions, to that extent is he creating a constructed force to be felt in wage-determination.

PRESIDENT'S MESSAGE

(Continued from Page 2)

ing the intervals. The responsibility for publishing as well as editing the Journal is now under the capable guidance of F. F. Groseclose of Georgia Tech., and we have every reason to be optimistic for its future.

A number of the standing committees are beginning to hit their stride, and we should soon see some tangible returns from this activity. This is particularly true of the Research Committee on Synthetic Time Systems who have set up some splendid objectives and outlined an ambitious program that should bring credit and commendation to the Institute.

It is regrettable that it was not possible for me to visit more of the chapters, but that is one of the drawbacks and penalties of a growing organization, since a certain size must be reached and fixed obligations met before funds can be available for travel and other activities.

With the firm knowledge that there is a need for the Institute and a growing potential in the field of Industrial Engineering, let us put our shoulders to the wheel and make its future secure. With your continued interest and support there should be no question of the end result.

PROGRAM
AIIE CONVENTION
Biltmore Hotel, Dayton, Ohio

FRIDAY, MAY 9, 1952

6:30 P.M. Board of Trustees Dinner
Dayton Room

7:30 P.M. Board of Trustees Meeting
Dayton Room
Open to all members of AIIE

10:00 P.M. Social Hour. All members of AIIE are cordially invited

SATURDAY, MAY 10, 1952

8:30 A.M. Registration—Foyer entrance to Main Ballroom

9:00 A.M. Program—Main Ballroom
John D. Coleman, Pres. AIEE presiding
Welcome to Dayton—John Farnbacher, Pres. Dayton Chapter AIEE
Report of Synthetic Time Systems Committee, K. T. Korn, Chairman
"Compulsory Arbitration in Basic Steel and Its Effect on Operations and Taxes"—Alfred Treadwell, Jr., Vice Pres. Sharon Steel Corp.

12:30 P.M. Luncheon
Martin C. Miller, Central Vice Pres. AIIE, presiding
Luncheon Speaker — James E. Trainer, Firestone Tire and Rubber Co.
"Management's Responsibility in Manpower Problems"

2:00 P.M. Business Meeting
John D. Coleman, Pres. AIEE presiding

6:30 P.M. Banquet
Introduction and Installation of New Officers
Presentation of Awards
Speaker—To be announced

A Special Program for the Ladies—Friday Evening and All Day Saturday

I E T N O U

Reported by COAOIETNAUF

Stephen Arthur Derry
Chairman

TODAY, the theme is BREVITY. Hence the alphabetical title to the committee's first report. "IETNOU" means Industrial Engineering Techniques New or Unusual. "COAOIETNAUF" means Committee on Application of Industrial Engineering Techniques to New and Unusual Fields.

The committee's objectives are:

1. Tabulate all reported applications of Industrial Engineering Techniques to New and Unusual Fields.

2. Prepare news items for publication in AIIE Journal.

3. Present at the annual meeting, the committee's choice of the most outstanding application of Industrial Engineering Techniques to New and Unusual Fields that came to the attention of the committee.

Among the unusual techniques, developed during World War II, was a new aspect of TIME MEASUREMENTS and practices. These applications to new fields spread rapidly. Today predetermined motion standards, with all of their complexities, are accepted as a modern approach to developing time standards.

Another War II product is the stress on "METHODS IMPROVEMENT" often referred to as Methods Engineering. "MI" or "ME" goes all the way back to the time when Solomon built his temple. Today, the practice has taken on color with the center of attention on the human being. The technique has made many major contributions to the postwar world in the conduct of business and industry. Tomorrow it will make equally great contribution to government at all levels from village through city, county, state, federal and international in its conduct in interchange of business operations with taxpayers and public-at-large.

It is now a recognized fact that "ME" has opened new expressways to the art of managing business and industry through the astounding findings of knowing in advance exactly what men are to do and the best and most economical way of performing a given task which owner, worker, investor, customer and taxpayer heartily approve and welcome as change for betterment. Through "ME" new avenues of approach to the evergrowing problem confronting business, industry and government—HOW TO EFFECTIVELY REDUCE OPERATING COSTS WITHOUT A LOSS OR SACRIFICE—have been copied with amazing success. Many new methods are yet to be unfolded.

Another interesting postwar industrial engineering technique practiced by top level management is a unit known as MANUFACTURING RESEARCH —"MR." Volumes have been published in report form to top management on projects undertaken by the "MR" group. Here are a few recent ones:

International Harvester, through its Manufacturing Research Division, the "MRD" of "IH," since 1947 tackled about 1000 assigned projects. The "know-how" obtained from these case studies brought about an annual saving of $125,000 on just one project, which reduced the car loading time of their finished product from 31 man hours to exactly one man hour per car. This freed more than 140,000 man hours annually for other useful purposes. Many other effective economies ranging from $10,000 to $100,000 annually were revealed and put into practice.

Still another unusual application of industrial engineering technique is what may be called a sister to International Harvester's "MRD." The label on this technique is "OR," which means OPERATIONS RESEARCH. This is also a product of War II.

Operations research employs the ultra-scientific approach—uses higher mathematics—to find quantitative bases for operating decisions. "OR" penetrates into the essential variables of any given situation. These variables are then correlated in a manner which makes analysis understandable by the layman.

"OR" follows a definite pattern. A study of past operations supplies the basic working facts. An explanation of each basic working fact provides data for the establishment of a theory to support the established basic fact. The theory coupled with the basic fact is then used for the determination of a prediction about future operation. The future prediction is then examined as various alternatives are applied in carrying them out in actual practice.

"OR" probably first came into existence at the Engineer School, Fort Belvoir, Virginia, where the effectiveness of equipment and weapons was studied. Other military schools such as the Command and General Staff and the Army War College adopted "OR" techniques in their case studies. The results were very satisfying. It was "OR" recommendations put into practice that put the well-executed German submarine warfare at Bay of Biscay out of business overnight. The counter measures derived through the "OR" technique uncovered the ways and means which stopped the strategy of the Germans.

"OR" recommendations during War II upset many criteria of Maintenance and Efficiency practices in industry. It was the knowledge of "know-how" obtained from "OR" projects during War II that solved the postwar airlift over Berlin.

Some of the applications of "OR" in business and industry today are the study of the uses of machine-controlled recording and signalling devices. It was the application of "OR" and its findings which made it possible for General Motors to announce the new automatic headlight dimmer on the 1952 Cadillac. The findings showed that the automatic dimmer eliminated the human equation of forgetfulness in manually dimming the headlight when a vehicle approaches. "OR" showed that the automatic dimmer, like the Chrysler hydraulic steering, and the universal adaptation of automatic transmission has greatly contributed to the reduction of automobile accidents due to such causes as blinding approaching headlights, steering fatigue of the driver, and time delay in manual shifting. All these improvements have contributed to the ease and comfort of motor vehicle commuters.

Military tactical applications of "OR" found its parallel in business and industry. Today, the principle of "OR" is adopted in solving problems in process scheduling, plant facility utilization, traffic control and material routing. The use of "OR" technique has spread from assembly line application and other factory operating units to fields such as conduct of sales and political campaigns. Note the technique used by candidates for public office. The winner in the current campaign for the high office in the White House may well contribute his success to the proper application of the "OR" technique as it applies in this field. National Cash Register Company, Dayton, Ohio, applies the "OR" technique in training its portfolio salesman. One visit to the classroom of National Cash Register's New York division vividly portrays how the "OR" technique can be applied to sales organizations.

Other nonmilitary applications of the "OR" technique fall into such categories as organizational problems, plant requirement, market research, studies of plant location, and measures of many difficult problems in personnel, labor and public relations.

Some projects now under study where the "OR" technique is applied are as follows:

1. MACHINE TOOL INDUSTRY: Determination of unit cost factors of producers employing semi-automatic multiple purpose machines.

2. COTTON INDUSTRY: Deviation causes between standard and actual costs.

3. TRANSPORTATION INDUSTRY: Measurement of the effectiveness of central control systems.

4. SHOE INDUSTRY: A better fitting of shoes with fewer produced sizes. Also, a better balance between shoe machine operation and shoe machine production.

5. VARIETY PRODUCT INDUSTRY: Effectiveness of budget allocation and distribution of sale promotion locations based on sales analysis.

6. STEEL INDUSTRY: Points in ingot rolling most subject to improvement.

7. PRODUCTION PLANNING: Analysis of policy factor in scheduling production to meet sales forecasts.

8. PRODUCT DISTRIBUTION: Measurement between sales advertising costs and losses due to returned sold goods or products as a result of the advertising.

Many new and unusual industrial engineering techniques will play a major role in solving tomorrow's problems of business and industry. Some of the fields into which the industrial engineer of tomorrow will infiltrate are:

1. LOWERING OF CLERICAL COSTS: Batteries of method specialists are already collecting standards data in clerical operations. Many clerical operations will be replaced by better and more efficient office machines.

The 1952 electric typewriters introduced a new and more efficient typewriter keyboard by placing essential keys at points requiring minimum movement of the fingers. It also eliminated duplication of keys and levers commonly found on manually operated typewriters. The result is better typing output not only in the quality of work, but in quantity with less effort and fatigue on the typist.

This is just the beginning of what is in store for office workers. There will be many innovations in accounting systems, inventory control records, reproduction and calculating machines, filing and record-keeping systems, office furniture, office work-area layout, etc.

(a) PERFORMANCE STANDARDS: Much emphasis will be placed on a closer tie between standard costs and budgetary control which will mean that the industrial engineer will have to apply ingenuity to devising better technique in establishing more accurate standards, and better up-to-date reports. The theme and objective will be in every case —"LOWER THAT COST."

Some solution must be found for adjusting standards to changing fixed costs. The present trend is a constant increase in fixed costs, which will affect break-even points. Management will demand lower break-even points and the task of meeting management's demands will fall on the industrial engineer.

2. CONTROLS: (a) QUALITY: Quality control by the technique of statistical sampling is becoming accepted more and more by industry. However, before it is universally accepted, many changes and innovations will have to be introduced. The field is wide open and a paradise for the industrial engineer who has untapped talents in statistical analysis.

Management will pay more attention to process capabilities, and quality limitation of processes. Management will want more standards in inspection methods. They will want more consistent facts on what is a "good" part and what is a "reject." Consistency in decision will be their objective. It will be up to the industrial engineer to find ways and means to establish the consistency demanded by management. Customer acceptance will set the quality standard more in the future than all other factors combined.

(b) QUANTITY: Output standards for production line workers are plentiful, but the surface has not even been scratched in the area of nonproduction workers. There will be new standards. Many not yet conceived in work areas such as service, clerical, maintenance, sales, engineering, research and "top brass." The reason for this trend is labor costs in the area of nonproductive workers is spiraling entirely out of proportion to the decrease created by the reduction of production employees.

3. COST ANALYSIS: No longer will management cope with the accountant's paper reports on cost analysis. Pressure will fall on the industrial engineer to come up with new approaches to fast cost analysis.

4. INCENTIVES: Today, management is strictly set on a "PROFIT ECONOMY STRUCTURE." The money inducement is the basic factor in all incentives. The feuding, and inequalities, created by present-day incentives will be greatly eased by more widely chosen financial incentives. There will

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ALPHA PI MU*

From a group of nine students at Georgia Tech who formed the original chapter in 1948, Alpha Pi Mu, the national industrial engineering honorary society, has grown to ten chapters and 798 members. There are chapters at the leading schools of industrial engineering and other chapters will be formed as the students organize and other schools become accredited in industrial engineering.

With this growth, Alpha Pi Mu becomes an important organization in the promotion of industrial engineering. Through its publications and alumni program, the society can materially aid in gaining further professional recognition and status for the profession of industrial engineering.

Last year, through the efforts of Dr. Paul N. Lehoczky, the past national president, and Jim French, executive secretary, Alpha Pi Mu was granted associate membership in the Association of College Honor Societies (ACHS), the recognized group for maintaining the standards of honor societies in American colleges. We are ineligible for full membership as that now requires ten years of active existence as a national society. This recognition of industrial engineering adds to the importance of the IE curriculum in the engineering field.

Chapters are limited to those schools which have an industrial engineering curriculum accredited by the Engineers Council for Professional Development. Each prospective chapter must be voted on favorably by the existing ones. To be eligible for election, an industrial engineering student must be in the upper third of his class if a senior or the upper fifth if a junior. Several chapters have established more restrictive scholastic requirements such as a smaller proportion of the class or a minimum average. The personal requirements are leadership, ethicality, sociability and breadth of interest.

Although the students now make up most of the membership, provision has been made for election as alumni members, those who would have been eligible for membership if the chapter had been in existence at their school when they were in attendance. Outstanding industrial engineers and IE faculty members may be elected to honorary membership. Graduate students can become active members.

At the latest report in March, 1952, Alpha Pi Mu had initiated 650 active, 93 alumni, and 55 honorary members.

At the biennial convention held at

(Continued on Page 18)

*R. M. Eastman, Associate Professor of Industrial Engineering, Georgia Institute of Technology.

Pace Rating In Work Measurement

... by Phil Carroll

PROFESSIONAL ENGINEER
AUTHOR
Timestudy Fundamentals for Foremen
Timestudy for Cost Control
How to Chart Timestudy Data

Rating studies, such as the one sponsored by S.A.M., are exceedingly important projects. The results should help us to solve one of the most vital problems in timestudy. The answer sought is a rate of working that can be adopted as a Normal measure of a "fair day's work."

The Normal is the base we use to set up standards for wage incentives. It determines the point where extra earnings begin. It is the rate of working expected in return for the base pay.

Standardizing the Normal is highly desirable for many reasons. Two should be mentioned here. Obviously, standardization would bring about consistency in work requirement. Standards and incentive premiums would be more uniformly fair. Secondly, standardization is becoming increasingly necessary because hourly rates for like work are getting to be more nearly identical.

Hourly rates are approaching uniformity by job class through wage surveys. Community wage rates are common knowledge. But we have not awakened to the necessity for surveys of the correlated Normals of work equivalents. That is a type of project our A.I.I.E. Chapters should be working on diligently.

Such surveys would present many difficulties. All of the commonly heard objections would be raised—"Our business is different," "ours is the Whosits plan," "we can't make any changes."

Are these objections sound reasons or are they excuses? How long can we continue with inconsistencies? What are the prospects in competition when we pay different prices for the same output?

We have different labor costs when we have like wage rates and different work standards. The differences in standards may result from different Normals in rating, relax factors and incentive plans.

Incentive Plan

Incentive plan differs for many reasons. One I want to mention. It is an accepted specification for incentive plans that is in error, in my opinion. The literature specifies that an incentive plan should be selected to suit the type of industry. But in contradiction, the experts in human relations tell us that incentives appeal to the best in human nature. Further, they tell us that human nature is the same the world over. If these are facts, then we are wrong in assuming that a type of industry has any bearing on the correctness of an incentive plan. Put the other way around, there seem to be good reasons why incentive plans should not be different.

If this is true, then the chief reason for differences in Normals for work standards would be washed out.

Relax Factors

The second difference is caused by inconsistency in relax factors. Here, relation is meant to include allowances for fatigue and personal. Such allowances vary between plants for good reasons and also by accident. Sometimes, the main difference is a factor stuck in to adjust for some phase of the incentive plan. This percentage cannot rightly be classified as a relax factor.

Now, if we exclude differences due to incentive plans, the relax factors themselves are not the same for like jobs in comparable plants. This is because the Normals are not the same. Whether the chicken or the egg came first, we do not know.

In this connection, there is another difficulty that we should be aware of. It appears to me that when we use a narrow range of relax factors to cover a wide range of work, we tend to shift our Normals to compensate. Maybe an example will emphasize the point. Suppose we use an allowance of 20% for fatigue. Assume the range of jobs covered is such that it would be more correct to apply 10% on the easiest and 30% on the hardest work in that range. Obviously, if fair standards are set, then the Normal has been shifted to compensate. A correct performance rating of 60 U/H has been called a 55 on the easiest work. A 60 Normal has been rated as 65 when the relax applied was 20% that should have been 30% in the example given.

This shifting of Normal is more real than imaginary. It has shown up in several training groups. What the right answer is remains to be proved. My suggestion is that we should have a standard for Normal and change the fatigue factors to suit the strenuousness of the work. As long as we mix rating with relax we must be aware of the fact that we expect the individual timestudy man will adopt different Normals throughout the range of work he studies.

Experience vs. Training

All of these differences show up when we put on a rating session in an S.A.M. Chapter. Some chapters have sent me summaries of their results. Usually, these include figures that reflect the amount of timestudy experience in the group. Those conducting and participating in the sessions seem to be impressed by the amount of experience.

Exerience in timestudy may not be any index whatever of skill in rating. So my question is, "How many weeks of training in rating did these men have?" The answer usually is, "Not very many." Of course, we all recognize that either experience or training in wrong methods may be worse than none at all. Lack of training is one of the big gaps that I think we are overlooking. Training needs to be more extensive than we realize. The meager information I have indicates a need for some 8,000 to 10,000 practice ratings. This rough measure is taken from a Learning Curve that summarizes the progress of about 100 trainees. Contrast the guesstimate of eight to ten thousand with the usual number of practice ratings and you see what I mean by lack of training. More particularly, ratings made in training are measured against some standards for accuracy. The error is known. Such practice ratings are not the same, therefore, as an equal number made as part of experience.

Aptitude

Then in training, another factor is pointed out. Some men can rate more accurately than others. Certain men can learn more easily than others. This becomes apparent when an individual's progress is plotted against a learning curve.

Obviously, the element involved is an aptitude. What that is, we don't know yet. How to test for it is even more vague. A number of people suspect that the aptitude is related to what we call rhythm. Some attempts have been made to check this hypothesis with the Seashore rhythm test. The check is too meager to show any conclusions either for or against. However, we must remember that some men can rate much better than others. In addition, we must search for the test that will select those who can learn to rate.

Personality

In conclusion, there is another phase of this subject that should be touched on. I refer to the personality of the timestudy man. He may have difficulties aplenty even if he has the requisite aptitude, training, and standards for Normal and relaxation factors. He may be unsatisfactory as a timestudy man because his approach is poor. If he causes a negative

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Plant Relayout --- Why and When?

...by W. Grant Ireson

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Paper presented before the San Francisco Bay Area Chapter of the American Institute of Industrial Engineers, Inc., March 6, 1952

Plant layout is one of the major areas of work for industrial engineers even though comparatively few companies employ engineers specifically for this work. It is very logical that the industrial engineer should be chosen for this work since plant layout is actually a specialized application of methods engineering, which has been a part of industrial engineering since its very beginning.

Every factory employs plant layout in some way, even though you may not find any formal organization for handling the layout problems as they arise. If you were to ask many factory managers whether or not their plants needed plant layout engineers you would probably get the answer "No." If the plant employs men, machines, or materials; if it receives materials and supplies and ships finished product; if it has office functions to be performed, or if it provides a service to the public, the plant has need of technical layout knowledge. The layout problems are being solved some way, and usually by a piecemeal method. The objective usually is to provide for immediate needs with very little thought being given to future problems that undoubtedly will arise. The results are very likely to be something less than the best, and actually are likely to contribute to new problems in the near future.

One of the difficulties in this matter comes from the concept held by many that layout applies only to new plants. They think nothing remains to be done about the arrangement of the physical facilities after the plant is put into operation. If this were true, there would be very little need indeed for layout engineers. The number of new plants planned each year is small compared to the total number of plants in operation. This is the minor and easier problem to be solved. The great bulk of the plant layout work that is done is in regard to the rearrangement of existing facilities in existing buildings. For every new plant that is planned each year there are hundreds of relayouts. Each of these is made within an existing building and among existing layouts of other departments with all the resulting complications. The presence of certain machines, processes, materials, handling equipment, personnel facilities, receiving and shipping departments, and facilities for the production of products other than the ones under consideration all add to the complications of replanning a certain division or department. These limiting factors are such that it is much more difficult to develop an over-all, long-run objective and to make each relayout contribute to this objective than it is to plan an efficient and effective layout for a new plant.

Perhaps it is advisable at this point to define plant layout. Plant layout consists of those procedures, practices and concepts by which the physical facilities of the entire plant are arranged relative to each other. It has as its objective an efficient working unit in which the human element is utilized for productive work and as little as possible is spent in carrying on nonproductive functions. Actually, plant layout is as much concerned with the arrangement of offices, storage facilities, materials handling and management functions as it is with the arrangement of machines within the departments and the departments within the plant. It is necessary to understand the modern concept of a factory before this ultimate objective can be understood. The modern concept of a factory is that the factory is a unified production machine; the building is simply a shell for the machine to provide the proper protection from weather, prying eyes, and sticky fingers. The factory should be as nearly an automatic machine as the type of manufacture and the line of products will permit. We are all familiar with the massive transfer machines in the automotive industry in which such parts as the motor block castings are completely machined by a series of operations on one machine. Each set of operations is performed simultaneously as the parts progress from stage to stage. The operator sits at the control panel ready to stop the machine if any single set of tools fails to function properly.

The factory can be compared with this transfer machine. The difference lies in the fact that there are many parts and each producing unit is not physically tied to the others. When one stops, all need not stop. Management sits at the controls ready to slow down one process, change the tools of another, rearrange the physical layout, buy new machines, or add new employees to keep all the parts of the factory working at a desired rate and in as great harmony as possible. Thus, the objective of plant layout is to obtain an integrated unit.

This concept of the modern factory should influence our thinking regarding the layout of the plant. Especially it should influence our thinking in connection with each separate relayout. It should dictate that an over-all plan which anticipates the future, for a few years at least, should be prepared before individual relayout problems are started. Each relayout should contribute to the over-all plan. Furthermore, relayout should not be limited to the rearrangement of machines and equipment, but should be extended to all other facilities that affect the production rate and production costs.

I imagine that many of you are saying something like this: "That's all right for some factories, but our plant is different," or "We produce dozens of items, and each one requires special treatment or processing so that it is a separate facility from all the others." However, the basic ideas here presented can be applied to some extent to all plants. Mushroom growth, rapid changes in product designs, rapid expansion of sales, hit or miss addition of equipment and employment of untrained workers have contributed to inefficient practices. Temporary decisions have resulted in poor layout in a great many instances. The layouts could have been better with no greater expenditure and with savings in operating expenses if the separate problems had been approached as parts of one large problem rather than as so many independent problems.

The title of this paper presents two questions which have a single answer. Relayout of a plant or portions of a plant are undertaken for economy reasons almost exclusively. It is considered whenever it is believed that the resulting savings will more than repay the cost of making the relayout. Thus a trite but true answer to the questions of why and when is: Relayout whenever the needs justify the expenditures for relayout. We are, however, concerned with obtaining a more useful set of answers than this one.

There are numerous reasons why relayout of a part or all of a department, or of several divisions of a plant, should be investigated. These reasons may be classified in several ways, but the following will serve our purposes. These reasons may fall under the headings:

1. Inefficient or ineffective existing layout.
2. Changes in products.
3. Changes in volumes.

Under each of these headings there are definite signs that indicate when a study

should be made to determine the possible savings resulting from a relayout of specific area. Most of these signs are similar in nature to those which all of you know and use in your methods engineering work. In fact, in many instances the relayout of a section of a plant is indicated by a motion and time study made for other reasons. Also, the solution, after the problem is located, may be based more upon ordinary principles of motion economy than anything else.

Inefficient or ineffective existing layout is nearly always indicated by such things as:

Congestion in specific areas;

Overtaxed temporary storage areas;

Failure to meet production schedules or shipping schedules;

Complaints from foremen that additional space, machines or workmen are needed to meet production schedules;

Damaged materials in temporary storage areas;

Unexplained drop in production rate as some of above items occur;

Poor quality of product;

Excessive inventories of work-in-process;

Complaints from workmen about speed-up, heavy work, or the foremen;

Complaints about comfort conditions (heating, ventilation, etc.);

Poor housekeeping;

High accident rate;

High labor turnover;

Frequent reassignment of skilled workmen to less skilled jobs;

Frequent loss of material-in-process;

Increasing burden costs for such items as production control, cost control, or supervision.

These are just a few suggestions which can be used for a rapid check-up to see if a relayout study will be justified. A preliminary study of the possible changes, and the resulting savings, will then reveal whether a relayout should be made. The form of the study will be very similar to the preliminary study which you use in methods work.

The improvements in layout can be expected to bring about such effects as reduction in direct labor charges, reduced burden charges, improved production rate, better supervision, fewer complaints from foremen and workers, and reduced time in process.

Changes in products result from changes in design to simplify production processes, deletion of old products and addition of new ones, annual model changes, introduction of new and more economical equipment to replace obsolete equipment and material changes or substitutions. Of course, management is well aware of the existence of each of these conditions and should advise the plant engineers far enough in advance so that the relayout necessitated by these conditions can be studied thoroughly before the deadline for the change. This advance notice not only assures that a complete study may be made but that careful plans can be worked out for the plant changes so that there will be as little interruption of production as possible. Each move can be scheduled for the maintenance men or millwrights, and preparation of outlets for power, water, steam, gas or any other service can be installed in advance of the actual move.

Changes in volume result from increased or decreased demand for existing products. This may be brought about by new product designs, obsolescence of products, increased public acceptance, etc. Here again the changes can be anticipated to a certain extent from market surveys, sales reports, and product development reports. However, the accuracy of prediction of the former set of causes may not be duplicated in this set of causes. Change in total volume is usually upward, since the great majority of manufacturing concerns grow in size and output over the years. The natural result is to expand the physical facilities by building additional buildings, purchasing new equipment, and adding to the work force. The problem of relayout is important from this viewpoint for two reasons. Frequently the additional investment of capital funds can be prevented or reduced by a careful relayout of existing facilities so that maximum output is obtained with present equipment and buildings. The other reason is that possible future expansion, especially in terms of additional buildings, is not often considered in the original factory plan, and the addition of new buildings actually increases the cost of certain burden items such as material handling, provision of heat, light and power, and relayout of existing facilities to make use of the added floor space. The long-range objective of factory planning should take into consideration the probable future expansion. Present layouts should be prepared so that future expansion can be accomplished with minimum interruption of existing facilities and still retain low operating costs.

Practically all of the reasons I have mentioned why plant relayout should be undertaken have revolved around economy considerations. Cost or expense is the great watchword in every industrial concern and it is only natural that most relayout projects must be justified on the basis of dollar savings versus dollar expenditures for the changes. There are, however, other measures of the effectiveness of an existing layout. To mention a few, there are:

Ratio of direct labor hours per unit to indirect labor hours;

Number of handlings of a part or product;

Distance a product travels in the course of manufacture;

Elapsed time from issue of raw material to completion of part;

Number of and complexity of forms used in controlling the production.

Each of these tests may be applied to an existing arrangement and then to a proposed plan to determine whether or not an improvement has been made.

Unfortunately, as long as a company is making a comfortable profit and paying an attractive dividend on its stock there seems to be little incentive to look critically at its practices concerning manufacturing processes, materials handling, personnel facilities, utilization of facilities and constantly increasing burden expenses. When competition makes it difficult to sell the product in the necessary volume to obtain a satisfactory profit, then management becomes disturbed. It begins to examine its practices to find means of reducing costs and regaining its competitive advantage. The program of action usually takes the form of pressure on foremen, supervisors and engineers to reduce costs immediately. The urgency of the problem often precludes the possibility of a systematic and thorough study of the problems and results in halfway measures to correct undesirable conditions. My point is that, in most of these instances, the very causes, and I am thinking only of layout conditions, could have been located and corrected by a systematic program of layout improvement before the conditions reached a critical stage and profits became unsatisfactory.

It is now possible to give a more plausible answer to the question, "When?" There are three schemes for timing the relayout of a plant or portions of the plant. The first scheme may be termed the "periodic layout," which is the type generally practiced where the company changes models every year or so. The second scheme may be called "continuous" in that the relayout is going on continuously throughout the plant with some master plan or schedule determining what projects shall be studied and in what order. The third scheme is called "accidental" for lack of a better name. This scheme has no master plan or schedule and the relayout possibilities are studied when someone thinks that improvements in a certain section can be made that will satisfy some particular need.

The first two schemes naturaly are more desirable from the viewpoint of industrial engineers who like to work toward some objective rather than depend upon the uncertainties of accidental programs. I do not mean to belittle the third scheme as a source of ideas and brilliant solutions. The workmen and foremen at the work stations are far more familiar with the intricacies of the job and the sources of waste than the engineers. Under any of the schemes for

timing the relayout program, the persons closest to the actual work should be consulted in all sincerity to obtain their suggestions for solutions before a plan is made, and these men should be asked to criticize the final plans before they are adopted.

The advantages of the first two schemes are probably obvious. Under each plan those persons responsible for the planning of the factory facilities can obtain an over-all viewpoint on the problems and formulate a long-range policy. Each individual problem can be keyed into this long-range program so that each layout complements the others. Having a plant layout group (or for that matter only one person on a part-time basis in small companies) assures that layout problems are someone's responsibility. There will be some continuity of the work, regardless of how infrequently layout problems arise. This group of individuals can develop a high degree of skill in assembling the facts of the cases, sorting out the irrelevant material, analyzing the data, and preparing the plan. The general knowledge of how to attack the problems will increase. The actual cost of studying layout problems and finding solutions will decrease, just as the costs of making methods studies decrease as the methods engineers gain experience, knowledge of the company's processes and equipment, and skill in handling the study.

Up to this point I have mentioned nothing about the effect of types of industry on the problem of why and when for relayout. In spite of the many classifications of industry which have been used for organization study, only two classifications are necessary for plant layout problems. These are (1) Continuous and (2) Interruptable. The continuous industry is one which must be operated twenty-four hours a day and seven days a week as a result of the processes. The reason the plant must be operated continuously is that it cannot be shut down on short notice without suffering severe loss of materials-in-process, damage to equipment, and high costs of starting the process again. Naturally, this classification takes in such industries as open hearths and blast furnaces, rayon mills, sugar refineries, paper mills, and many other industries of similar nature.

The interruptable industry is one which can be shut down on short notice without incurring any loss through damage to equipment or work-in-process and only suffers the cost of lost production time. This is characterized by job shops of all kinds, woodworking, metal working, and most of the mass-production industries, such as automobile plants and home appliance plants.

It is also obvious that you may find examples of each kind of industry within one plant.

The difference between these two types of industry as regards relayout exists primarily in the timing of the layout. The continuous industry plants are customarily designed as balanced producing units. Continuous flow of materials through many stages is provided by balancing the productive capacity of each stage through the use of different numbers of units. It is clear that a relayout of one production unit in a continuous industry may easily necessitate the rearrangement of many other units in the line. Even obsolete equipment is sometimes used for many years because the cost reduction resulting from its removal and the installation of a new piece of equipment will not overbalance the high costs of all the related changes.

On the other hand, individual units can usually be removed and replaced, or placed in other positions, in interruptable industry plants without necessitating other changes. Therefore, frequent changes which result in cost savings can normally be justified more easily in interruptable plants. The result is that great care is taken in the design of a continuous type plant to be absolutely sure that the plan will work efficiently and that the very best equipment and procedures have been incorporated in the plan. The building is the last item to be designed. The plan must have the prospect of operating for many years at an efficient level without major changes or relayout. This does not mean that new equipment, new processes, or improvements in product specification shall be ignored. It simply means that such companies should set up a procedure for periodic examination of recent developments. Through an engineering economy study it should determine if any of the developments can be introduced into the plant at a saving in cost per unit produced.

Such care is not frequently taken in the design of interruptable plants. In fact, buildings have been built for the production of a specific product even before the number of machines required for the production volume had been calculated. This, perhaps, is not as bad as it sounds. If the building has been designed with certain characteristics which facilitate relayout and provide for flexibility in arrangement, it may actually be better than a building planned around a specific layout of the required equipment.

One of the principal ideas that should be included in a long-range plan should be provisions for easy and inexpensive relayout of equipment. The use of bus duct for electric power and lighting, grid system distribution of steam, compressed air and gas, high floor load capacity, and ease of securing machines to the floor

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without permanently damaging the surface are some of the factors which increase the flexibility of the building. Flexibility enables a company to change layouts as frequently as necessary for effective production and effective utilization of the available floor space. The easier it is to actually make a change in layout, the easier it is to justify the change through cost reduction.

IETNOU

(Continued from Page 13)

be incentives for more nonproduction workers including supervisors.

5. TOMORROW'S INDUSTRIAL ENGINEER: The drive for greater productivity with less production costs will force management to regard the industrial engineer as the professional member of top level management. The main function of tomorrow's industrial engineer at top management level will be that of coordination and integration of working teams with a common objective.

Yes, the wheels of tomorrow's industry will revolve around the industrial engineer's decision, as the lives and billions of dollars in property hovers over the decisions of today's railroad and airport "DISPATCHER." Not a train moves one inch over the main tracks of a railroad, nor does a plane take off or land without the "GREEN LIGHT" from the dispatcher.

Tomorrow's industrial engineer will be the dispatcher for industry. He will fix the purchase department schedule of items to be purchased. He will peg the raw material in process. He will set finished product inventory level. He will establish personnel policy. He will be the guardian of the budget. He will be the coordinator and adviser of these activities.

These are just a few of the tasks the future industrial engineer of tomorrow's industry will be doing as a key member of top management's industrial team. The opportunities are unlimited.

(The committee's next report is to include comments on the "LABAN SYSTEM" and its application to industrial engineering.)

PACE RATING

(Continued from Page 14)

attitude of mind, his ratings will be low. You may say, "What difference does that make if he rates correctly?" Certainly it makes no difference if we think only of arithmetic. But what about this thing we call attitude, industrial relations or human engineering? What about the selling, persuasion or acceptance that is necessary before the objective can be attained? In my opinion, we should do most or all of our "selling" during the timestudy process carried on to establish standard data. In this we should be able to bring about good performances and be obligated thereby to apply above Normal ratings. That comes back to the personality skills of the timestudy man. He should induce good performances by his approach. When he can fairly apply ratings above Normal, he has gained the confidence of those being studied. He has gained general acceptance of his timestudy work.

Superior sales ability must not be used to cover up poor standards. We have to solve the technical phases of ratings. We must push on until we find answers to the question, "What is a fair day's work?" Yet we must remember that technical formulas do not solve human problems. We can apply our findings only through the timestudy man. We cannot substitute a technical accuracy for a human engineering skill. Therefore, we must not expect to solve the important problems of timestudy by technical strap-hangers. The need for skill in man-to-man relations will continue to be the most important element in good timestudy work even when we have settled all the technical questions.

ALPHA MU

(Continued from Page 13)

Georgia Tech on February 28, 29, and March 1 of this year, Charles W. Brennan of Georgia Tech was elected national president replacing Dr. Lehoczky, the first president of the society. Bert H. Norem, head of the industrial engineering department at Syracuse University, was named vice-president. The three councilmen selected are Clifton A. Anderson of Penn State, Herb Manning of Virginia Polytech, and H. G. Theusen of Oklahoma A. & M. The able executive secretary and moving spirit, Jim French, was re-elected. Col. Frank F. Groseclose of Georgia Tech and Dr. Lehoczky are advisory members of the executive council. The convention also laid out a program for building up our alumni membership and forming alumni chapters and for strengthening and expanding the society.

The society publishes *The Cogwheel* three times a year. Al Thomas of Atlanta has recently retired as editor. The new editor is now being chosen by the executive council. In addition to news of the society, *The Cogwheel* contains articles of general interest to the profession.

With the founding and growth of Alpha Pi Mu, the profession of industrial engineering now has a student honor society with large and increasing membership to aid in strengthening the profession.

LOCAL CHAPTERS

(Continued from Page 7)

from the older members or to extend it to the junior members. Where student chapters are close by, opportunities exist for the guidance of student members.

If a community or industrial area has ten or more industrial engineers meeting A.I.I.E. eligibility requirements, it has the potential membership necessary to start a chapter. The amount of work required to accomplish and maintain the organization is surprisingly small—and richly rewarding in personal professional development.

Complete instructions on how a chapter may be organized is just a part of the service offered by the National Headquarters, through the Chapter Organization Committee. For more complete information or for instructions on how the benefits of a local chapter can be made available to you, write to National Headquarters or direct to M. A. Payne, Chapter Organization and Extension Committee, 1352 Croyden Road, Cleveland 24, Ohio.

Committee members: H. W. Spitzhoff, Robert Heller & Associates; D. R. Lamimon, U. S. Gage Corporation; R. E. Shafer, West Virginia University; M. A. Payne, Chairman, The Lubrizol Corporation.

COOPERATIVE RESEARCH

(Continued from Page 5)

that interesting as these results may be in themselves it is the general approach, the basic orientation, of this work which carries the broadest implications with respect to the future development of the field. It is an orientation which may offer a place of repose for arguments over the question of whether time study is or is not scientific. From his examination of the evidence the author takes an emphatic stand that time study is not scientific, and doubts that it is likely to be. But he also holds that the question is in reality of no great consequence:

". . . There is no evidence to show that any time study system in practice has been or is likely to be accepted or rejected on the basis of whether it is or is not a science. When a system is used to determine rates for incentive pay purposes the practical criterion, from the employee's viewpoint, is that he be able to earn somewhat more on the average than the man who holds a job which is pay-rated just below his, and that he may do this without exerting what he considers to be an undue amount of effort. If the time study man can set acceptable rates with a substantial degree of consistency it is no fundamental concern to the workman whether he does it by means of a crystal ball, shrewd guess, or electronic computer. It is true that the

employee finds it more difficult to contest a rate produced by what has been represented to him as a 'scientific' system; but this is no solution in the long run."

According to the author, the concept of a "scientific system" of time study has a use similar to that of the "ideal" thermodynamic Diesel cycle. It is useful to theoreticians, researchers, and designers but has nothing to do with the selection of an actual Diesel engine to perform a specific practical service. The selection of an actual engine from among several alternative choices is related to the function which it is to perform and upon considerations of first cost, operating cost, ease of maintenance, etc. Similarly, he says, the evaluation of a time study system for solving problems must be based entirely upon practical considerations. An entire section of the treatise is devoted to a discussion of the practical functions of time standards and the practical criteria which may be used in selecting techniques for performing those functions.

While practical criteria are emphasized for matters relating to the solution of practical problems, the role of the scientific investigator is also of great importance according to this analysis.

". . . The function of science is to provide the knowledge on which progress is based. Consequently, the pure scientist is concerned with criteria by which he judges the validity of knowledge and not with criteria which may be appropriate for judging the relative usefulness of solutions to practical problems . . . The post-mortem judgments of a research pathologist are likely to have a substantially higher degree of reliability than the expert opinions of a medical diagnostician. To most of us, however, there is little practical appeal in the fact that diagnoses by autopsy are more scientific, and so we reserve to the research pathologist the job of advancing knowledge so that the practicing diagnostician may improve the reliability of his decisions. This illustration suggests the fundamental relationship between the scientist and the practitioner upon which a sound profession may be built. It is the professional obligation of the scientific investigator to assure the validity of the conclusions which he advances. It is the professional duty of the practitioner to familiarize himself with scientific developments in his field and to utilize them to the best of his ability in the solution of practical problems."

The research studies reported in this work illustrate well the sort of scientific research which needs to be conducted in this field. This research required the use of analytical techniques which may not be thoroughly familiar to every practitioner. The results of the analyses, however, have rather far-reaching implications that may be quite readily appreciated. In a statistical analysis, for example, of the basic data from a number of synthetic time systems the author and R. W. McGuire have found some rather substantial discrepancies among the various systems. These differences appear to be of such magnitude that if any one of the systems should be accurate, the others could not be. Analyses of these differences also show that they are systematic in nature and cannot be accounted for simply by differences in the concept of a normal performance or by the inclusion of allowances.

In addition to the three appendices dealing with research studies, the reader also finds a thoughtful discussion concerning Dr. Gomberg's proposals for the use of control chart criteria in evaluating time study data. Both logical analysis and experimental evidence are offered to show that Dr. Gomberg's proposals should be regarded as hypothetical and that there may be good reasons why control chart criteria would actually be inappropriate for time study applications.

The impression may be gained that the findings may not readily lend themselves to application by the practicing Industrial Engineer. The researchers are fully aware of their obligation to their practicing colleagues that their findings must be integrated in such a manner that practical, applicable methodologies may evolve. These methodologies are expected to be increasingly more practical, economical, useful, and effective tools for the better solution of an increasingly more complicated society.

There is no aspiration that this group will ever supply the cure-all for the ills of the industrial world, however, it is looked forward to the evolution of an era of objectivity in Industrial Engineering. It is our belief that this can be achieved through searching for more 'absolute truths' through cooperative research.

9. Korn, K. T., MANHOOD OF INDUSTRIAL ENGINEERING, Berk & Assocs., Cleveland, 1951

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